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A SURVEY OF THE SCIENTIFIC VALUES OF THE PROPOSED LIMEKILN CREEK RESEARCH NATURAL AREA MONTEREY RANGER DISTRICT, LOS PADRES NATIONAL FOREST

(purchase order 686 -PSW-76)

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INTRODUCTION

Location and Principal Distinguishing Features

The Limekiln Creek drainage is a small (ca. 5478 acres) but extremely rugged and diverse area of high, rocky crags, steep, wooded slopes, plunging brush and grass-covered headlands and deeply forested canyon bottoms. The mouth of the creek is located ca. 57 road miles south of the Monterey Peninsula in south-central, coastal Monterey County and about 1.6 miles south of the settlement of Lucia. The greatest portion of the area is under the management of the Monterey Ranger District, Los Padres National Forest. Coastal access to the drainage may be had from State Highway 1 from the camping concession operating at the mouth of Limekiln Creek or via the gated road ca. ½ mile north of the Limekiln Bridge on Highway 1. Another gated road leads off behind Sacred Heart Retreat ca. ½ mile south of Lucia on Highway 1 to the western edge of the drainage. Inland access to Cone Peak and the upper drainage of Hare Canyon and Limekiln Creek may be had via the Nacimiento Road by taking Cone Peak Road at the Nacimiento Summit and traveling north several miles. By this route it is about a 1½ hour drive from King City and about a 40 minute drive from the coast. A striking elevation range from sea level at the mouth of the creek to 5155 feet atop Cone Peak within just 3¼ miles, gives this spot the greatest elevation gradient along the coast of the United States, outside of Alaska. Being centrally located along the California Coast, the area serves as a meeting and mixing zone of biotic community types typical of both Northern and Southern California. The redwood and mixed evergreen forest are near their southern out-

posts here, the north coastal scrub meets its southern analogue the coastal sage scrub, and the coastal prairie of Northern California meets the more xeric and southerly valley grassland in this area. The abrupt, substantial elevation changes, plus the diversity of slope exposures, climatic conditions and edaphic situations give this small area a wealth of vegetation types, unequalled in any other coastal area of California. In addition to being a meeting ground, the Santa Lucia Range has a number of its own endemic species and unique community subtypes which add considerably to the diversity of vegetation in the Limekiln Creek drainage. The Limekiln Creek drainage also offers superior opportunities for study of the effects of short distance, well-defined climatic changes (California maritime to interior and montane) on vegetation and other biotic elements. The establishment of a R.N.A. in order to preserve its great potential as a site for biological studies of many kinds is well justified.

History of Scientific Interest

The Cone Peak - Limekiln Creek drainage area has been of interest to botanists for many years. Howitt and Howell (1964) in their flora of Monterey County list many specimens, some of them quite unique, collected in the vicinity of Cone Peak and Limekiln Creek. For a more complete history of botanical exploration see Appendix I of Griffin (1976). The area has long been known as one of the most accessible spots for observing the endemic Abies bracteata (Santa Lucia Fir). Field biology classes from University of California, Santa Cruz and U. C. Santa Barbara and other schools have made several visits to the area. One of the earliest broad-based studies concerning the area was the Vegetation Type Map survey conducted in 1933 (USFS). The study covered several large portions

of the Santa Lucia Mountains and succeeded in mapping among other areas the vegetation of the entire Limekiln Creek watershed on a small (15') scale. Another study just recently completed (Griffin, 1975) included a floristic and phytogeographical survey of the higher peaks of the Santa Lucias, one of the most intensively studied sites being the Cone Peak area.

Interest in protection of the drainage as a scientific reserve was first initiated in 1965 by Dr. K. S. Norris, then of UCLA. As the developer of the University of California's Natural Land and Water Reserves System, Norris recognized the area's diversity and great potential for ecological studies of many types. Between 1965 and 1970 there was a delay in the establishment of a reserve pending settlement of other project negotiations then in progress between the University of California and the Cowell Foundation. In March 1970 the UCSB NLWRS committee gave formal support to the establishment of a Limekiln Creek Reserve and in December 1971 the UCSC committee also gave formal support and sent along a detailed letter outlining the values of the area. In 1972 the University-wide NLWRS committee prepared a formal six page letter reviewing the information supporting the establishment of the so called Limekiln Creek - Santa Lucia Fir Reserve, including ownership conflicts, etc. As an appendix to this report Dr. J. R. Haller of UCSB prepared a five page list outlining the various habitat types occurring in the Limekiln Creek drainage. Following these U. C. proposals it was found that a less circuitous route toward protection of the area (not involving special use permits from the U. S. Forest Service, etc.) would be the establishment of a Forest Service managed R.N.A. In mid 1974 Dr. Jim Griffin of Hastings Natural History Reservation

sent a letter to the Los Padres National Forest Supervisor outlining the desirable aspects of establishing two R. N. A.'s. in the Cone Peak - Limekiln Creek region. Later in 1974 another letter was sent to the Forest Supervisor by the Executive Director of the California Natural Areas Coordinating Council urging the Forest to give some form of protected status to the area. In April 1975, Robert Lancaster, the Forest Supervisor, in a letter to the Regional Forester, requested an ecological survey of the Cone Peak - Limekiln Creek site. It was decided by the R5 PSW committee on Research Natural Areas in Berkeley that the area was most easily divided into two candidate R.N.A.'s. One would cover the upper South Fork of Devil's Canyon to be established specifically to preserve the dense Sugar Pine - Santa Lucia Fir forest, and the other would cover the Limekiln Creek watershed from Cone Peak to the sea. In early 1976 the purchase order was issued which initiated this report.

JUSTIFICATION

Biological

Transect of vegetation types from coastal bluff to Santa Lucia mixed conifer:

Perhaps the single most compelling reason for the establishment of the Limekiln Creek R.N.A. pertains to the highly varied ecological structure of the drainage. It is almost incredible to conceive of a single small area which could contain elements of ten distinct California plant communities as defined by Munz and Keck (1949), but indeed, this drainage does. The following communities are well represented with most of their characteristic dominants: northern coastal scrub, coastal sage scrub, redwood forest, mixed

evergreen forest, and chaparral. Such communities as coastal bluff, coastal prairie, valley grassland, foothill woodland, and yellow pine forest are each represented by a fair portion of their characteristic elements. As would be expected, the preceding communities are not always precisely defined and often intergrade, with some very interesting and unusual local plant associations resulting. The anomalous mixture of such communities as valley grassland and coastal prairie and coastal scrub and chaparral is apparent in this watershed. The elevational cline of scrub communities from coastal scrub through sage scrub to chaparral as well as the cline of grassland types from coastal prairie to valley (interior) grassland and of the sclerophyll forests from mixed evergreen through coast live oak woodland to canyon oak woodland is also a unique situation, which if examined, could possibly elucidate the relationships between many California plant communities. Several closely related species normally segregated and geographically separated into different communities occur side by side here. These include such north coastal scrub and coastal sage species as Eriophyllum staechadifolium and E. confertiflorum, and such north coastal scrub and chaparral plants as Mimulus aurantiacus and M. bifidus ssp. fasciculatus, and Eriogonum parvifolium and E. fasciculatum ssp. foliolosum.

Biogeographical Significance:

The Limekiln Creek drainage by virtue of its centralized location in California and its high elevation areas, retains a number of biogeographically significant taxa, either reaching their distributional terminus in the area or representing populations isolated at upper elevations.

Association types: The broadest categories of phytogeographically significant plants include several entire associations

which reach their distributional limits near the study area. The most conspicuous of these is the redwood forest. Sequoia sempervirens and many of its associates in Northern California such as Oxalis oregana, Viola sempervirens, Whipplea modesta, Hierochloe occidentalis and others reach their southern limits in the vicinty of Salmon Creek ca. 12.5 miles south of Limekiln Creek. In this southerly outpost of its range the forest is generally quite restricted to moist canyon bottoms, spring-sides, and the like, although local pockets of redwood forest may reach unusually high elevations in sheltered sites (up to 3200 ft. in the Limekiln drainage). Another less restricted forest type,the mixed evergreen forest, reaches its southern limit in the Santa Lucia Mountains, although individual constituent species continue farther south into Southern California. This forest, however, at its best development occurs no further south than the Northern Santa Lucia Mountains. In the study area this type is well represented and widespread on the more sheltered slopes of the middle elevations. Another association reaching its southern limits in this part of California is north coastal scrub. This community, which usually occupies a spot between the coastal strand and the redwood forest is well represented on the lower seaward slopes of the Limekiln drainage. Above this the slopes often support a coastal sage scrub-type community which intergrades with the north coastal scrub. This type of association featuring Artemisia californica, Salvia mellifera, etc., occurs commonly along the coast from San Luis Obispo Co. south through Southern California, but reaches its northern distribution in this area. The final association reaching its distributional terminus in this area again comes from the north.

The grassy knolls at the lower elevations (below ca. 1500 ft.) closely resemble the coastal prairie community typical of coastal Northern California.

Disjunct populations: In addition to these entire associations another group of plants, many of which are characteristic of middle elevations in the Sierra Nevada, Transverse, or Inner North Coast Ranges, occur in the vicinty of Cone Peak, Junipero Serra Peak and in some cases, a few other high peaks of the Santa Lucias, far from their more typical localities. Most important of these are taxa such as sugar pine (Pinus lambertiana), Cycladenia humilis var. venusta, Allium burlewii, Cheilanthes gracillima, and Lotus argophyllus var. fremontii. Many of these species are found near the summit of Cone Peak and are also represented in the adjacent South Fork of Devil's Canyon R.N.A. Several rare or endemic species also occur near the summit of Cone Peak, but these are best treated as an important value of the Devil's Canyon R.N.A. (See Griffin, 1976).

Specific range limits: Another group of plants have a more or less continuous distribution, but reach either their northern or southern distributional limits in this area, these include such species as Arabis breweri, Calochortus albus var. rubellus, Penstemon corymbosus, Nemophila parviflora, Streptanthus tortuosus and Erigeron petrophilus from the north and Yucca whipplei ssp. percursa, Monardella villosa var. subglabra, Penstemon heterophyllus ssp. australis, Collinsia childii and Mimulus subsecundus from the south.

The Influence of Climate and Topography upon Limekiln Creek Ecosystems:

A substantial elevational gradient, coupled with proximity to the ocean, produces a great deal of climatic variation within the

Limekiln Creek drainage. As is typical of much of coastal California the summer-dry Mediterranean climate is often modified by advective fog which may persist for weeks on end along the shore and on up into the valleys. This fog creates a cooling, moist blanket which shelters such relatively mesic communities as the redwood forest, lower mixed evergreen forest and coastal scrub from what would otherwise be a hot, sunny, and dry summer. Just above this low fog layer at elevations usually ranging from 1000-1700 ft. the cooling maritime influence of the fog is lost almost entirely and the upper elevations of the drainage are hot and dry in the summer months. While temperatures at the mouth of Limekiln Creek may rise only into the low 60's (^{o}F), temperatures on a 3000 ft. ridgetop may commonly be 25-30 ^{o}F higher at the same time. Thus, the redwood forest (except in perennially moist spots) and the coastal scrub are confined to areas of summer fog while more sclerophyllic drought-resistant associations such as the chaparral and various mixtures of mixed evergreen forest take over on the slopes above the fog layer. In the winter months this inversion is typically replaced by a more conventional system, where temperatures, modified by the ocean, remain relatively warm at the lower elevations and become progressively cooler at higher and higher levels. Year-round average temperatures are therefore rather uniform at low elevations, but are quite varied at upper elevations. In fact, a fair amount of snow falls each year at the highest elevations. This more interior, montane-type climate is undoubtedly responsible for the relict stands of such typically Sierra-montane trees as sugar pine and incense cedar on Cone Peak. Precipitation varies widely from the shore to the summits of Cone Peak. The University of California

NLWRS committee estimated about 20 inches of precipitation at the beach, and as much as 60 inches in some of the upper canyons. The climatic variation found in the Limekiln Creek drainage offers great potential to researchers interested in climatological tolerances of plant species or communities. Numerous other possibilities exist for research into the field of climatic barriers on the distribution of various other organisms. Topographic and physiographic barriers are quite pronounced within the study area. Slopes with a south aspect may be covered with dry chaparral or grassland while adjacent north or west-facing slopes may be clothed with dense mixed evergreen or Santa Lucia mixed conifer forest. The many abrupt discontinuities create complex vegetational mosaics within the watershed.

Slender Salamander Speciation:

In recent years, Dr. David Wake and his students at the Museum of Vertebrate Zoology at U.C. Berkeley have determined that two species of Slender Salamander; Batrachoseps relictus and B. nigrascens inhabit the Big Sur coast. B. relictus, the more northerly species,occurs within the study site, while B. nigrascens reaches its known northern distribution just south of Limekiln Creek. According to Wake, the Limekiln drainage is a possible meeting ground for the two species and a hybrid species swarm may be expected in this area. The two species are virtually identical in the hand and sufficient sampling and genetic testing has not yet been conducted on animals from the study area to fully determine their taxonomic status.

Geological Significance

According to William Dickinson in a letter to Jim Griffin the Limekiln Creek area is part of a charnockitic terrane stretching north to Grimes Canyon along the west slope of the Coast Ridge. Compton (1960), Wiebe (1970), and others feel these rocks may be Pre-Cambrian. If so, Dickinson says they are the only rocks that old between the Transverse Ranges and the Northern Cascades. Apparently these are the only charnockitic rocks described west of the Continental Divide in North America. Another important geological feature of the Limekiln Creek drainage is the Sur-Nacimiento thrust fault which passes across the lower and western portion of the drainage (Reiche, 1937). This major fault zone is a complex series of high and low angle faults that juxtapose a northeast block of crystalline rocks (the Salinian Block) against a southwest block of sheared Franciscan rocks. The Sur-Nacimiento Fault is the westernmost of three major tectonic boundaries in Central California. The tectonic events in this fault correlate with rapid continental margin subduction for California. According to Weibe (1970)the dip-slip tectonite structure and parallelism in age of the two contrasting basement terranes strongly suggest that the Sur Fault Zone is near or part of an ancient subduction zone that was active in the Cretaceous. Wiebe states that the metamorphic zonation in the Franciscan rocks near Limekiln Creek is similar to the pattern seen in the Klamath Mountains tectonic contact. This suggests that the Sur Fault Zone represents the continuation of the Great Valley Subduction Zone which has been offset hundreds of kilometers by the San Andreas Fault.

PHYSICAL FEATURES

Topography:

Rugged. A single word, characterizes the topography of the Limekiln Creek R.N.A. This roughly oval drainage is wider (4 miles) than it is long (3¼ miles). It consists of three major tributaries, the largest being Hare Canyon, followed by the West Fork and the Main Fork of Limekiln Creek. The drainage is oriented toward the south with the two highest points, Cone Peak (5155 ft.) and Twin Peak (4843 ft.) at its northern end. From these two points the canyons of the three tributaries sweep steeply and abruptly down to the sea. Radiating from Twin and Cone Peaks are the four main ridges, two of which form the outer boundaries of the drainage and the other two form the inner divisions of the three main watersheds. All three of the canyons are over 1500 feet deep in parts, remarkable relief for such a small drainage. In general the slopes throughout the area are steepest at the upper reaches of the canyons and at the bases of the ridges where they drop abruptly to near sea level. Numerous limestone escarpments and outcrops intensify the rugged terrain in the vicinity of Cone Peak. The steep plunge of the ridges near the junction of the three main forks may correlate with the transition from the more resistant crystalline rocks of the Sur Series on the upper slopes, to the softer sediments of the Franciscan Formation along the coast.

Geology:

The Limekiln drainage includes Pre-Cretaceous rocks (including limestone), Jurassic-Cretaceous Franciscan metamorphosed sediments and metavolcanics, and Mesozoic granitic rocks. The most

extensive of these formations is the Pre-Cretaceous metamorphic Sur Series which covers over 3/4 of the drainage, including all of the upper portions east of the West Fork and northeast of the foot of Twitchel Ridge and the junction of the West Fork and the Main Fork. These crystalline rocks are primarily quartzites, granofelses and gneisses, with many layers of amphibolites, schists, calcite marbles and metadolomites. Compton (1966) suggests that these rocks were metamorphosed by a granitic source and that the origin of the metamorphism was in the southwest corner of the Junipero Serra Quadrangle (near the Cone Peak area). This area also has many dolomitic marbles, forming conspicuous outcrops on the main ridges (i.e. Cone Peak, Twitchel Ridge). According to Hart (1966) the largest of these marble outcrops ranges from 100-150 feet thick and extends southeast across the study area and for ca. 6 miles to the western flank of Chalk Peak. The limestone used in the limekilns on the West Fork came from a landslide accumulation. Hart (1966) interprets this area as either a thin veneer of landslide debris underlain by Sur Series metamorphics or a part of a large, partly crushed block that slid downslope from the main limestone mass further up the ridge. Granitic veins and dikes make up 5-15% of most of these marble-limestone outcrops. Many of these dikes are considered by Compton (1966) to be partial melts from the surrounding Sur Series rocks. The one large granitic outcrop on the west-facing slope above the West Fork is ca. ½ mile long and ¼ mile wide and was considered to be a portion of the Santa Lucia Formation of intrusive granitics by Reiche (1937). Wiebe (1970) theorizes that many of these intrusives are mid-Cretaceous (ca. 70-109 m.y.) but charnockitic rocks found by Compton (1960) in the Cone Peak area

suggest that some intrusives may be roots of plutons that are as old as the Pre-Cambrian. Wiebe feels that the rocks of the Salinian Block,(which include the granitics and Sur Series), may be related to very similar rocks in the Transverse Ranges and Western Mojave Desert, some of which have been dated as Pre-Cambrian. The wide separation of these similar rocks is a result of the action of the San Andreas Fault.

The narrow band of metamorphosed Franciscan rocks is separated from the Sur Series and related granitics of the Salinian Block by the Sur-Nacimiento thrust fault. This fault runs down the middle of the West Fork Canyon and cuts southeast following the abrupt bend of the creek then crosses the foot of the ridge between the Main Fork and Hare Canyon. The Franciscan terrane of the Lucia area studied by Gilbert (1973), is predominately intercalcated metasandstone and siltstone with the metasiltstone about twice as abundant as all other rocks. Most of the local Franciscan rocks were sheared by fault action. At the mouth of Limekiln Creek and extending up the coast ca. one mile is an outcrop of greenstone which shows pillow formations, indicating clearly its underwater volcanic origins (Reiche 1937). There appear to be no major serpentine outcrops associated with the Sur-Nacimiento Fault within the drainage. However, Reiche maps two small outcrops on the ridgetop forming the western boundary of the drainage, one between 1500 and 1750 feet and the other between ca. 2500 and 2800 feet. The ages of the Lucia area Franciscan metasandstones are between 70 and 88 million years (Gilbert, 1973). This gives a minimum late Cretaceous age for metamorphism in the area. This is nearly identical with the plutonic rocks of the adjacent Salinian Block, and Gilbert suggests that the

uplifting and cooling of Franciscan and Salinian plutonic rocks took place concurrently.

Climate:

No long-term climatological data is available for the drainage. The best information showing differences in climate from low to high elevations along the Big Sur Coast is the data collected by Talley (1974). From this, good comparisons can be made with climatic situations at coastal sites, mid elevation canyons, and high peaks of the Limekiln Creek watershed. In this area, less than 2% of the average annual precipitation occurs between June 1 and September 30, and 3/4 falls between October and the end of February. Summer storms are rare, according to Talley, even on the highest peaks. Along the coast,precipitation is highest where the Santa Lucia Mountains rise most abruptly to the highest points, and maximum precipitation occurs on the lee slopes of these high peaks and ridges. The east face of Cone Peak was estimated to receive over 90 inches per year. Much of this arrives as snow in the colder months. Talley noted about 3 feet of wet snow on the east face in December 1970. In contrast, a 13 year record from Pacific Valley along the coast at ca. 300 ft. elevation six miles south of Limekiln Creek indicates an average of 28.82 inches with essentially all precipitation falling as rain. The winter and early spring temperatures at high elevation sites are substantially lower than those in coastal canyons or other coastal points. The mean temperature at Cone Peak (1,298) from December 26 to January 22, 1970-71 was 3.9^{o} C while at the same time in the Spruce Fork of Salmon Creek (792m) it was 5.7^{o} C and at Point Piedras Blancas (near sea level) it was 14.7^{o} C. Diurnal temperature ranges for winter and early spring

were smaller at Cone Peak (ca. 4° C) than at Piedras Blancas (ca. 7° C). Summer temperature inversions are very stable. From June 30 to August 13, 1970, the average mean temperature at Cone Peak was 23.1° C and at Spruce Fork 22.4° C. The higher mean temperature at upper elevations results from the inversion raising the nighttime minima of upland sites (because no fog) during late spring and early summer. The mean summer minima and maxima for 1970 at Cone Peak and Spruce Fork were: 18.1 and 27.0° C and 16.4° and 29.4° C respectively. According to Talley the temperatures were approximately equal during this period due to the progressive lowering of the stable inversion layer that summer. There were, however, significant differences in relative humidity (lower at Cone Peak). The seasonal temperature variations are greater on ridges and summits than in canyons and ravines, despite a more stable diurnal temperature range at high elevations than is found at the immediate coast. Talley feels this is due to maximum and minimum temperatures rising and lowering by equivalent amounts during warming and cooling trends at the higher elevations. Sites above 1200 m elevation are not free from frost periods lasting 24 hours or more until the wet season is essentially over in late April. Talley records the annual temperatures ranges in coastal canyons (Spruce Fork) from -11° to 40° C and at Cone Peak from -10° to 36° C.

Pertaining to humidity, Talley found that the maximum vapor pressure deficit was much higher at Cone Peak than in either coastal or interior canyons. The maximum V.P.D. is likely to occur during morning hours when the sun warms the peak's rocky lee slopes and dry breezes from the east waft over the summit. By afternoon the sun is warming the mountain's coastal slope and winds coming up the

west slope are more humid. They are cool enough to stop the continued temperature rise in the afternoon. At the high elevation sites "inversion" temperature-humidity patterns can become established during periodic warm-dry periods in the spring, and even during winter, although the actual temperature values are lower than those seen in the typical summer regime.

From the head of Hare Canyon looking southwest. Fog level about 1600 feet (July 1976)

VEGETATION

The vegetation types in the Limekiln Creek drainage are complex and not easily separated into distinct communities. Although the formations of grassland, scrub (including coastal and chaparral types) and sclerophyllous forest-woodland are well defined and there are often abrupt alternes between them, the intergradation of the various communities making up the formations typically produces poorly marked, gradual clines, which ascend the ridges and canyon slopes throughout the area. Many of the higher elevation communities such as the Santa Lucia mixed conifer forest and its subtypes and the canyon oak woodland also intergrade rather freely with one another and with lower elevation mixed evergreen forest types. This is not the case for all vegetation types, however, and a restricted community such as the redwood forest is readily distinguishable and easily delineated. The rapid elevation gain from the coast tends to spatially compress vegetation zones. This compression of zones combined with biogeographical considerations, climatic, edaphic variations, and abrupt slope differences creates unusual juxtapositions and overlaps of communities, (i.e. redwood with coastal sage scrub, redwood and canyon oak forest and coastal scrub and chaparral) which are not found away from the Big Sur area.

Few attempts have been made to categorize the vegetation of the area inclusive of the Limekiln Creek drainage. The VTM survey in 1933 produced 15' vegetation maps covering the drainage. In 1972 J. R. Haller of UCSB compiled a list of habitat types of the Limekiln Creek drainage, and in 1976 Jim Griffin described the vegetation of the upper South Fork of Devil's Canyon. The classification

of vegetation types has been somewhat different for each account and range from very simplified generalized types as in the VTM survey to more complex analyses and breakdowns (Haller and Griffin). Haller's categories conform more or less directly with the Annotated List of California Habitat Types (Cheatham and Haller, 1975) and also apply directly to the Limekiln drainage, thus comparisons with his classification scheme will be made in this report.

The accompanying map (Figure I) portrays many of the community sub-types rather inadequately and is basically an approximation of the actual extent and composition of the vegetation. Because the great diversity of vegetation subtypes found in the Limekiln drainage precludes adequate quantitative sampling of each of them, this report is primarily a qualitative description of the vegetation found there.

Scrub and Chaparral:

Coastal Scrub: This vegetation in its most characteristic form occurs along the steep to moderate slopes southwest or east facing slopes directly above the ocean (most occurs along the coast just outside of the actual Limekiln watershed). It is distinguished by a dense, closed growth of shrubs of moderate height (ca. 4-6 feet). Within this zone may be local areas of steeper, rockier ground which supports a lower, sparser growth of similar shrubs interspersed with species more typical of coastal bluff vegetation (á la Munz, 1959) such as Dudleya Caespitosa, Eriogonum latifolium, Erigeron glacus, etc. The overall dominant species of the local coastal scrub are Artemisia californica, Rhus diversiloba, Baccharis pilularis var. consanguinea, Rhamnus crocea and Mimulus aurantiacus with such

important herbs and grasses as Achillea millefolium, Agrostis diegoensis, Galium nuttallii, Phacelia malvaefolia var. loasaefolia, Eucrypta chrysanthemifolia, Gnaphalium bicolor, G. californicum, G. ramosissimum and Castilleja foliolosa. This community is most closely related to the central coastal scrub subdivision of the California coastal scrub (Cheatham and Haller). However, this community is quite variable even as it occurs below 800 feet elevation along the immediate coast. A typical stand on Franciscan greenstone ca 3/8 mile northwest of the Highway 1 bridge has the dominants listed above but also a number of other sub-dominants including Salvia mellifera, Eriophyllum staechadifolium, Lupinus variicolor, Zauschneria canna, Convolvulus cyclostegius, Rubus vitifolius and Haplopappus squarrosus. In a less dense stand at similar elevation on steep sloped Franciscan metasandstone ca. ¼ mile southeast of the Highway 1 bridge the scrub is dominated by Haplopappus squarrosus, Lupinus variicolor, Salvia mellifera, Artemisia californica, Eriophyllum staechadifolium, Eriogonum parvifolium, and Lotus benthamii, along with a number of species more characteristic of higher elevation sage scrub sub-dominant such as Lotus scoparius, Yucca whipplei var. percursa, Heteromeles arbutifolia, Stephanomeria virgata, Rhamnus californica, and Eriophyllum confertifolium. The steepness of slope and the soil type appear to be very influential in determining the composition of the coastal scrub. There seems to be no part of the drainage which shows an uninterrupted continuum of "pure" coastal scrub through to "pure" sage scrub. There is an area approaching this in the extreme southern portion, ½ mile east of the Highway 1 bridge.

A number of patches of scrub intermediate between those described

above are found where dominants of both types occur together (i.e. on the west side of the West Fork Canyon near "point 1037"). It becomes very difficult to define coastal scrub beyond the immediate coast as both the sage scrub and coastal scrub elements naturally share many dominants. However, species such as Eriophyllum staechadifolium, Astragatus nuttallii, Eriogonum parvifolium, and convolvulus cyclostegius are good indicators of coastal scrub and even Baccharis pilularis var. consanguinea is a fairly good indicator, dropping out in the lower reaches of sage scrub. The mapped area covered by coastal scrub is ca. 170 acres. It ranges in various forms from 20-1200 feet.

Ceanothus thyrsiflorus (Blue bush) Scrub: This easily mapped subtype of the coastal scrub and sage scrub is characterized by tall dense bushes of Ceanothus thyrsiflorus or locally C. griseus and C. sorediatus. C. griseus is intermixed primarily at lower elevations when the subtype is surrounded by coastal scrub. C. sorediatus occurs with C. thyrsiflorus at higher elevations in the sage scrub. The shrubs are generally rather senescent in appearance with long lanky branches, sparsely foliaged except at the tips. This subtype rises several feet above the surrounding coastal scrub or sage scrub and appears to be fairly restricted to an association with these two communities. Occasionally stands of C. sorediatus will occur within chaparral, but here they are less aggregated and are usually found as individual shrubs. Stands of C. sorediatus also occur in ecotonal areas between mixed evergreen forest, oak woodland and grassland. Here they appear to be successional, being replaced by mixed evergreen forest or oak woodland. This subtype

is generally found on steeper slopes than the two scrubs and often in rather rocky areas. The area covered by this subtype is approximately 180 acres and it ranges between elevations of 100 and 3000 feet elevation. Ceanothus thyrsiflorus scrub is known as timberland chaparral on the VTM maps. It is not given separate status by Haller or Cheatham and Haller.

Sage Scrub: This major scrub community is known as sage scrub on the VTM maps and coastal sage by Haller, but in this area it is not considered separately from the central coastal scrub by Cheatham and Haller. Their view may be well taken because it grades so gradually into the coastal scrub that it could be considered an upper elevation manifestation of the central coastal scrub. We hold the view that the scrub found on generally exposed south slopes between ca. 200 and 2500 feet, away from the immediate coast is more closely related to the sage scrub of Southern California. The scrub is composed of low (1½-3½ ft.) shrubs in stands generally not as dense as those found in coastal scrub. In many cases the shrubs grow on steep, rather barren soil on slopes of limestone, metamorphics and Franciscan rock types usually removed from the immediate coast. The dominants in this sage scrub are Artemisia californica, Salvia mellifera, Mimulus aurantiacus (lower), Mimulus bifidus ssp. fasciculatus (higher), Eriogonum fasciculatum, Rhamnus crocea ssp. ilicifolia, Rhus diversiloba, Lupinus albifrons and Lotus scoparius. The sage scrub and the successional transitional scrub discussed next are of notably drier aspect than the coastal scrub, particularly at higher elevations where the sage scrub frequently takes on such species as Adenostoma fasciculatum and Yucca

whipplei ssp. percursa, which are also characteristic of the chaparral. Sage scrub sites are frequently dominated by one or two species, the most common being Salvia mellifera and Artemisia californica. A number of shrubs and herbs of lesser importance occur in the sage scrub, many of which are shared with either coastal scrub or chaparral (For these see Appendix III). Only a few species seem restricted to the sage scrub these include such localized species as Salvia leucophylla. The rockier, steeper areas within the sage scrub are often dominated by cryptogams such as Pellaea mucronata, P. andromedaefolia and especially Selaginella bigelovii. This community reaches its peak diversity in open,rocky east-facing exposures where numerous grasses and herbs occur along with the shrubs including Castilleja affinis, Gnaphalium bicolor, G. microcephalum, Sitanion jubatum, Galium angustifolium, G. californicum, Clarkia rhomboidea, C. speciosa, Stephanomeria virgata, Cuscuta californica, Lupinus hirsutissimus, Chorizanthe douglasii, C. membranacea, Eriogonum elongatum, Chrysopsis villosa var. sessiliflora, Stipa pulchra, etc. In contrast, the dry south-facing slopes as above the Twitchel site have few herbs and only two or three dominant shrubs. The resemblance at this location, to presumably alleopathic stands in Southern California is quite striking. The sage scrub covers approximately 400 acres and ranges from ca. ¼ mile from the coast to ca. 2 miles inland.

Transitional Scrub: This category describes the largely successional, low (2-4 ft.) light density, scrub midway in character between the sage scrub and chaparral communities. It should perhaps be considered as two distinct successional scrubs one resulting in a climax chaparral, the other in climax sage scrub.

However, the patches of this scrub that we have observed often had similar dominant constituents whether they were associated with sage scrub or with chaparral. In either case the dominants of this association are Eriogonum fasciculatum, Lotus scoparius, Chrysopsis villosa var. sessiliflora, Penstemon breviflorus, Haplopappus squarrosus, Lupinus albifrons, and Yucca whipplei ssp. percursa, along with herbs typical of the grassland and sage and chaparral communities. The explanation for this minor "community" seems to lie in the area's grazing and fire history. At most of the sites where this vegetation type is found it is replacing grassland which was at one time (pre-1950's) maintained by burning for the purpose of keeping grazing land open for livestock. Eriogonum fasciculatum, Lotus scoparius, and Chrysopsis villosa var. sessiliflora, are frequent colonizers throughout the middle elevations of the drainage, but are particularly conspicuous in areas adjacent to grassland. The climax vegetation reached in many cases appears to actually advance beyond either chaparral or sage scrub and may be Quercus agrifolia woodland. For example, in certain spots on the western flanks of Hare Canyon and on the east slope of the Main Fork Canyon, this type of scrub is being colonized by young bays, coast live oaks, and madrones. In some cases, the edaphic situation appears to preclude the development of anything more advanced than chaparral or sage scrub (as on steep, rocky south-facing slopes).

The last major fire which would have cleared the grasslands was apparently in 1948 (600 Acre Fire Report, 1948). The past 29 years have seen a gradual advance of scrub into the grassland. The transitional scrub type is the first obvious major step in this transformation. There are many stages in the transition to scrub,

chaparral, or woodland and a variety of examples exist on the two main inner ridges of the drainage. The increase in abundance of more typical sage scrub and chaparral climax species such as Salvia mellifera or Adenostoma fasciculatum has led us to include these types under the chaparral or sage scrub communities when mapping them. Because this transition type does not show to its full extent on the map we must emphasize its importance as an indicator of rather rapid vegetational change in the drainage. The area of this vegetation type is ca. 150 acres and it occurs from about 1300 to 4200 feet elevation.

Chaparral: This well known sclerophyllous scrub is represented in the drainage by two major subtypes. One of these, the chamise chaparral is quite constant in its composition over a wide range of elevations, while the other, the so-called mixed chaparral is more complex in its constituents and it varies widely in its species composition from low to high elevations. Both of these subtypes are equivalent to the categories of the same name listed in Haller and Cheatham and Haller.

Chamise chaparral is easily characterized at a distance by its denseness and dark green color indicating the typical exclusive dominance by Adenostoma fasciculatum, the average height being ca. 3½-6 feet. This type of chaparral is correlated with steep, unfertile, generally south or west-facing slopes. The xeric nature of this subtype is apparent in the paucity of understory herbs and sparse duff accumulation. The lowest elevational limits of chamise chaparral coincide with very steep, nutrient-poor granitic soil on the West Fork at ca. 1400 feet while the highest chamise stands occur on the southeast flanks of Cone Peak at ca. 3700 ft. on marble

and metamorphics. In many places the chamise is in almost pure stands, but there are also a number of areas where other species of the mixed chaparral such as Heteromeles arbutifolia, Ceanothus papillosus var. roweanus, Arctostaphylos glandulosa, etc. occur as important members. Obviously chamise and mixed chaparral are closely related vegetation types. The chamise chaparral is generally the predominant vegetation on the steepest, poorest slopes that can be tolerated by any type of scrub.

Mixed Chaparral: Mixed chaparral occurs in varying forms from ca. 1500 to ca. 4800 ft. elevation. Between these extremes a number of dominance and subdominance regimes exist. The overall mixed chaparral dominants are Arctostaphylos glandulosa, Heteromeles arbutifolia, Adenostoma fasciculatum, Mimulus bifidus ssp. fasciculatus, Ceanothus integerrimus and Yucca whipplei ssp. percursa. These species are prevalent throughout a wide range of elevation and edaphic situations. Mixed chaparral occurs on all major rock types in the drainage and is generally on south, west or east slopes of more moderate steepness than the chamise chaparral stands. The mixed chaparral is a taller association than chamise chaparral occasionally reaching from 12-15 feet, but generally ca. 5-10 feet in height. It often houses a number of herbs and subshrubs, particularly in less dense, rocky stands. Selaginella bigelovii, Clarkia rhomboidea, Cordylanthus rigidus, Monardella villosa var. subserrata, Stephanomeria cichoriacea, Galium californicum, G. nuttallii and Zauschneria californica are common understory constituents. On the lower and mid elevation slopes and ridges it may grade into the sage scrub and at the higher elevations may intermingle with the canyon oak woodland. Typical scrub oaks such as Quercus dumosa and the serpentine-

inhabiting Q. durata appear to be largely absent from the drainage, but the scrub forms of Quercus wislizeni, Quercus chrysolepis, and even Lithocarpus densiflorus become important constituents at many chaparral sites. Mixed chaparral may have a successional relationship to oak woodland and mixed evergreen forest, as was mentioned in the transitional scrub section. In certain places, for example on the east slope of Hare Canyon, numerous small, senescent ridge top patches appear encroached upon by surrounding sclerophyllous forest. The most species-rich chaparral occurs at elevations between ca. 3000 and 4400 feet. On higher ridge tops a number of species such as Lotus argophyllus var. fremontii, Trichostema lanatum, Lonicera interrupta, Clematis lasiantha, Dendromecon rigidus, Ceanothus papillosus var. roweanus, C. dentatus, Lotus crassifolius, Garrya flavescens var. pallida, Arctostaphylos hooveri, Penstemon breviflorus, P. corymbosus, Eriodictyon californicum and Stipa coronata occur in fair density. The continuum with the sage scrub is apparent throughout the lower and mid levels of the chaparral and in these areas species such as Artemisia California, Lotus scoparius, Eriogonum fasciculatum var. foliosum, Rhamnus crocea ssp. ilicifolia, Ceanothus sorediatus, Haplopappus squarrosus, and Pellaea andromedaefolia are well integrated in with more typical chaparral dominants.

The burning history of the Limekiln drainage chaparral is not clear. Portions of it were burned at the mid and lower elevations in the fire of 1948, but certainly other patches have burned since then, including one recently burned patch of chamise on the east-facing slope of Hare Canyon ca. ½ mile west of Vicente Camp, which showed pronounced charred stumps and many resprouts in August 1976.

The proportion of senescent chaparral is high, however, being particularly dense and overmature on the ridgetops at upper elevations. The area covered by mixed chaparral is ca. 240 acres and by chamise chaparral ca. 450 acres. The first true chaparral occurs ca. 1 mile from the coast.

Grassland:

Large expanses of grass and herb dominated land occur on the central ridges and slopes of the upper drainage ranging from ca. 800 to 4600 feet. As is mentioned by Haller, there is a gradual transition between a grassland of coastal prairie character below the summer inversion layer, to a more interior-type high-elevation grassland. It appears to be fruitless to draw a boundary between the two types as the transition is so gradual, but most of the coastal prairie influence is lost above ca. 1700 feet. The coastal prairie is not particularly well developed. The best representative stands occur near the Twitchel site between ca. 800-1100 ft. Here such species as Ranunculus californicus, Sisyrinchium bellum, Pteridium aquilinum, Zigadenus fremontii and Brodaea pulchella occur with the annual Bromes, Avenas, and Festucas, Eschscholzia californica, Erodiums, etc. much as they do in true coastal prairie farther north. The coastal character drops off appreciably, moving up-slope just a few hundred feet from the Twitchell site. The native bunch grass Stipa pulchra becomes locally common as does Paeonia californica, Chlorogalum pomeridianum, Eremocarpus setigerus, Trichostema lanceolatum, Plagiobothrys nothofulvus, Phacelia imbricata, and Cirsium californicum.Further up the slope of Twitchel Ridge other herbs such as Microseris heterocarpa, Linanthus ciliatus, L. androsaceus, L. liniflorus, Lagophylla ramosissima, several species

of Chorizanthe (C. douglasii and C. membranacea most common), Lotus salsuginosus, L. humistratus, Salvia columbariae, Trifolium microcephalum, T. tridentatum, T. bifidum, Madia gracilis, Calycadenia truncata, Lupinus latifolius, Eriogonum virgatum, and the grasses Avena barbata, Bromus mollis, B. rubens, B. tectorum, Poa howellii, P. scabrella, Sitanion jubatum, Festuca megalura and Festuca myuras become dominant. The higher elevation herb and grasslands have a more open habit with herbs often just as important as grasses, particularly in steeper, rocky areas. The persistence of grassland in the Limekiln drainage is dependent primarily upon burning as was mentioned in the previous section on transitional scrub, but it also appears to correlate with slope (generally south slope) and substrate (usually on non-rocky argillaceous soil). The successional status of the local grassland is unclear. Although it is definitely being replaced in some areas by transitional scrub, there also appears to be a long history of grassland on the central ridges, particularly on the heavy marble and metamorphic soils on moderate slopes. This is evidenced by the extensive, apparently stable, coast live oak savanna-woodland bordering the grassland. This interior type of grassland is similar to Cheatham and Haller's cismontane native grassland, which they describe as a climax type on fine textured clay soils and is frequently bordered by oak woodland. But other areas dominated by introduced grasses and "weed" species such as milk thistle, Silybum marianum, horehound, Marrubium vulgare, and others appear to be trampled and over-grazed and seem to be largely maintained by the cattle grazing on the Twitchel Allotment. Fire-clearing has had a long history in the area as well, and was a very common practice before the 1950's. Under the

present circumstances the ca. 750 acre area covered by grassland in the Limekiln drainage would seem likely to decrease in size in the future.

Forest:

Redwood Forest: This familiar Northern California coastal community is the most mesic forest in the drainage. It is restricted to creek bottoms and shady slopes at lower elevations and becomes almost entirely riparian in the upper reaches of the drainage where it ascends canyon bottoms in isolated groves to 3200 feet (on the West Fork). The redwood forest is also the most distinctive of the forests in Limekiln, the indicator tree Sequoia sempervirens being large and easily distinguishable above the surrounding mixed evergreen forest. Included within the redwood forest is the true riparian element with such trees as Alnus rhombifolia, Salix coulteri, and Platanus racemosa. These species occur along streams locally throughout the area with Platanus being more common in the sunnier openings. A number of semi-riparian species occur in the creekside redwood forest including Acer macrophyllum, Myrica californica, Petasites palmatus, Boykinia elata, Aralia californica, Adiantum pedatum var. aleuticum, and Woodwardia fimbriata. The local redwood forest also contains many typical redwood species such as Oxalis oregana, Viola sempervirens, Trillium chloropetalum, T. ovatum, Polystichum munitum, P. dudleyi, Vaccinium ovatum, Rubus parviflorus, Hierochloe occidentalis, etc. The most diverse redwood forests occur near the lower parts of the drainage, particularly in the lower West Fork and in Hare Canyon. In the upper canyons redwoods become completely restricted to canyon bottoms and the understory here is much less diverse, generally dominated by species shared with the

shadier mixed evergreen forest such as Sambucus mexicana, Smilacina racemosa var. amplexicaulis, Disporum hookeri, Trientalis latifolia, Ribes menziesii var. hystrix, Fragaria californica, Osmorhiza chilensis, etc. The redwood is generally the only dominant tree, although such species as Lithocarpus densiflorus, Umbellularia californica, Acer macrophyllum, and Pseudotsuga menziesii may be sub-dominants. Occasionally Abies bracteata occurs with redwoods in the middle and upper drainages (i.e. upper Hare Canyon). The relationship of the redwood forest to the mixed evergreen forest is much as it is throughout North Coastal California, with the redwoods occupying the most mesic sites and the mixed evergreen the slightly drier surrounding sites. The most closed stands of redwoods are found on alluvial creek bottoms and they tend to form a mosaic with the mixed evergreen forest on north-facing slopes even at low elevations, (i.e. the lower West Fork and Hare Canyon). Redwood forest occurs almost to the mouth of Limekiln Creek ca. 200 yards from the ocean, but the trees here are stunted and sculptured by salt spray-laden breezes. Redwood forest covers about 800 acres of land in the Limekiln drainage.

Broad-leaf Sclerophyll Forest: Included within this forest formation are three major vegetation types which can be viewed as running along a moisture gradient. The most mesic forests are of the mixed evergreen type, giving way to the coast live oak woodland on middle elevation more exposed canyon slopes and knolls. On the steeper, shallow soils of mid and upper elevations the canyon live oak woodland replaces the coast live oak and continues up south-facing slopes to the top of Cone Peak.

Mixed Evergreen Forest: This is the most diverse of the sclerophyll forests and is the most extensive single vegetation type in the drainage, ranging in various forms from ca. 200 feet to 4000 feet and covering an area of ca. 1200 acres. This type coincides with the mixed evergreen forest of both Haller and Cheatham and Haller. Its ecological position is generally described as following the upper and/or inland margins of the redwood forest and attaining best development on north-facing slopes in the Santa Lucia Mountains and other southern portions of its range. In the Limekiln Creek drainage, the mixed evergreen forest is dominated by various mixtures of the following trees: Arbutus menziesii, Lithocarpus densiflorus, Umbellularia californica, Quercus wislizeni, Acer macrophyllum, Quercus agrifolia, Q. chrysolepis, and Pinus coulteri. In general the most mesic canyon stands are dominated by Lithocarpus, Umbellularia, and Acer macrophyllum. These stands are often intermingled with or adjacent to redwood forest and have a mesic understory of Trientalis latifolia, Similacina racemosa var. amplexicaulis, Osmorhiza chilensis, Dryopteris arguta, Symphoricarpos mollis, Adiautum jordani, Whipplea modesta, etc. The most diverse form of mixed evergreen forest is found on rather steep north-facing slopes as on the east slope of Hare Canyon where all of the major dominant trees are present as well as an understory of Rhamnus californica, Symphoricarpos mollis, Rosa gymnocarpa, Sambucus mexicana, Rhus diversiloba plus a number of grasses and herbs including: Hieracium argutum var. parishii, Delphinium nudicaule, Saxifraga californica, Lathyrus vestitus ssp. puberulus, Bromus grandis, Festuca californica, Elymus glaucus, Melica hartfordii, M. imperfecta, Calamagrostis rubescens, Phacelia circutaria var. hispida, Calochortus

albus, Iris douglasiana, Stachys bullata, Galium californicum, Carex globosa, etc. The understory of the mixed evergreen forest (including herbs and shrubs) is the best developed of any of the forest types in the drainage and the density of native grasses is impressive, particularly on the north-facing slopes of Hare Canyon. In the upper canyons Abies bracteata and Pinus lambertiana are occasionally found in stands within the forest. On the more exposed upper slopes Pinus coulteri, P. ponderosa and Quercus chrysolepis become increasingly important as this forest merges with the canyon oak woodland and the Santa Lucia mixed conifer forest. The mixed evergreen forest appears to be best developed on the schists and gneisses of the Sur Series. On the rockier limestone it is generally dominated by Quercus agrifolia and Umbellularia californica. On the metasediments of the Franciscan Formation Q. agrifolia and Arbutus menziesii are generally dominant (as on the east-facing slopes of the West Fork Canyon.

Coast Live Oak Woodland: A well-developed woodland dominated by Quercus agrifolia is found on the slopes and knolls of the two central ridges. In appearance it ranges from a savanna-like habit where it borders the grassland, to a more closed canopy woodland where it merges with the mixed evergreen forest on the slopes. The ecological position of this community in the Limekiln drainage is similiar to its characterization in Cheatham and Haller. It is described as commonly occuring adjacent to and intergrading with mixed evergreen forest, but is generally somewhat drier and is not as dense. The understory in this community is generally not as well developed as that of the local mixed evergreen forest, with a

more widely spaced shrub layer of Rhamnus californica, Rhus diversiloba, Rubus vitifolius, etc. and with a sparser herb cover consisting primarily of Collinsia heterophylla, Gnaphalium californicum, Madia elegans, Sanicula crassicaulis, etc. under the more closed stands. A number of herbs and shrubs from the chaparral, grassland and sage scrub occur in the coast live oak forest understory where it borders on those vegetation types. In some rockier, limestone areas the oaks give way to Umbellularia groves. These often appear to be clonal and they densely cover certain outcrops at the edge of grassland such as above the Twitchel site at ca. 1500-1800 ft. The understory in these stands is generally very sparse and as in the Q. agrifolia woods may be almost entirely destroyed locally by cattle aggregations. The Umbellularia stands may be considered as a distinct subtype of mixed evergreen forest as Cheatham and Haller do, but the small size of the stands and their occurrence as a grassland border type in this area place them closely with the coast live oak woodland.

The stability of the Q. agrifolia woodland particularly around grasslands is unclear, grazing and browsing by cattle and native mammals seem to be inhibiting seedling and sapling growth. In more protected sites such as in sage scrub and chaparral some seedlings are becoming established. The stability of the oak woodland would seem to be tied to the stability of the grassland that it borders. With the encroachment of transitional scrub on some areas of grassland it would be expected that oak seedlings may eventually become established in the developing scrub. Young live oaks at the edge of certain scrub-lined ravines on the west slope of Hare Canyon may be evidence of this. The best developed Q. agrifolia stands occur

on fine-grained and clay-rich soils derived from limestone and metamorphics. The elevational distribution of this type is from ca. 1000 to 3500 feet. At the upper reaches of the woodland Pinus ponderosa may become an important sub-dominant and Quercus chrysolepis and Q. wislizeni may become important co-dominants. Q. agrifolia commonly hybridizes with Q. wislizeni in these areas and in the drier portions of the mixed evergreen forest verging on oak woodland. The coast live oak woodland covers about 520 acres.

Canyon Live Oak Woodland: On the high, steep slopes of the upper drainage a low woodland composed primarily of Quercus chrysolepis predominates. Cheatham and Haller term this the canyon live oak forest and Griffin (1976) calls it the Quercus chrysolepis phase of the mixed hardwood forest. This vegetation type is generally transitional between the lower elevation broad-leafed sclerophyll forests and the higher elevation, more mesic, coniferous forests. This type typically forms a low, scrubby woodland with little understory on steep rocky outcrops (limestone or metamorphics) and south slopes. A forest with taller Q. chrysolepis mixed with Pinus coulteri, or P. ponderosa and Umbellularia is found on somewhat gentler or less exposed slopes. (On the vegetation map this forest subtype is separated from the main canyon oak woodland because of the conspicuous, emergent pines which are sub-dominants). At the summits and ridge-tops the woodland may merge with mixed chaparral with Yucca whipplei ssp. percursa, Garry flavescens var. pallida and Arctostaphylos glandulosa becoming common sub-dominants. The herb and shrub layer is sparse, but contains a number of interesting high elevation species including Galium clementis, Galium californicum ssp. luciense

Arabis breweri, Castilleja martinii, Cheilanthes intertexta, C. gracillima, Asclepias californica var. greenei and Erigeron petrophilus, which are not found in other parts of the drainage. At high elevations on sheltered north slopes, the canyon oak woodland merges with Abies bracteata and Pinus lambertiana of the mixed conifer forest.

The canyon oak woodland is a very stable vegetation type. Q. chrysolepis is the ultimate vegetation type on the steepest high rocky ridges and slopes and replaces Q. agrifolia woodland as the dominant xeric sclerophyll forest type on higher knolls and ridges. It may be advancing locally into senescent mixed chaparral as on Twin Peak. Like the mixed chaparral, the low stands of Q. chrysolepis appear to be dependent upon fire for rejuvenation. The dense, spindly sprouts of Q. chrysolepis on the steep slopes of Cone Peak are probably correlated with a higher fire frequency there. The area covered by this community is about 510 acres and it ranges from ca. 2600 ft. to 5155 ft.

Santa Lucia Mixed Conifer Forest: This community is more extensive and better developed in the adjacent South Fork of Devils Canyon, but various elements of this forest and small portions of the true mixed phase occur in the Limekiln Creek drainage. Cheatham and Haller consider this forest under two separate headings. Their Santa Lucia fir forest refers to the more mesic mixed phase and their Coast Range mixed conifer forest refers to the phase dominated by Pinus coulteri and/or P. ponderosa. Haller includes both types in a category called South Coast Range conifer forest. There is a unique situation in the Santa Lucia Range with Sierran conifer species such as Pinus lambertiana and P. ponderosa occuring in the same area with South and Central Coast Range species like Pinus coulteri and the

endemic Abies bracteata. We have chosen to consider this association as a single type of conifer forest, but the community should be divided into three subtypes: the mixed phase, the ponderosa pine phase, and the coulter pine phase. The mixed phase contains Abies bracteata, Pinus lambertiana, Pinus coulteri, Quercus chrysolepis, and locally Arbutus menziesii, Lithocarpus densiflorus, and Umbellularia californica. This phase occurs primarily on steep, northwest or east-facing slopes. This type of forest coincides with the transition type of Abies bracteata community described by Talley (1974) and Griffin (1976). This is the only subtype that contains mature trees of Abies bracteata because on these steep rocky slopes with about only 40% cover, fire is precluded. The shrub stratum is largely composed of scrubby canyon oak and other tree saplings. The herb layer is sparse, with Galium clementis and G. californicum ssp. flaccidum being among the most conspicuous. This type covers about 90 acres between ca. 3900 and 4700 ft. at the upper end of the drainage.

A large Pinus ponderosa woodland occurs along the western ridge above the West Fork of Limekiln Creek in a mosaic with oak woodland and mixed evergreen forest. We did not visit this area as it occurs largely on private land west of the forest boundary. It appears to be an open woodland with Q. agrifolia, Arbutus menziesii, and Quercus chrysolepis as dominants. The ponderosa pine subtype covers about 140 acres ranging from ca. 1700 to 3700 ft.

Pinus coulteri is commonly associated with the higher elevation, more xeric mixed evergreen forests, the canyon oak woodland and the mixed phase of the Santa Lucia mixed conifer forest, but does occur as a dominant locally on dry ridge tops and south-facing slopes.

It covers ca. 90 acres in small stands found throughout the drainage between ca. 2300 and 4300 feet. The understory is sparse and related to surrounding vegetation types. The presence of Pinus lambertiana, P. ponderosa, and Calocedrus decurrens along with Pinus coulteri and Abies bracteata in the Cone Peak - Limekiln Creek area does not imply that there is a strong Sierran-type mixed conifer forest element here. Although Pinus ponderosa and P. coulteri may occur together in very open stands (usually dominated by species of broad-leaf sclerophylls) they do not occur in exclusively pine dominated forests as in the conifer forest habit of the mid-elevation Sierra Nevada. P. lambertiana and Calocedrus are found in relict stands and do not mix with each other or with P. ponderosa, although P. coulteri and A. bracteata may occur with them. The type of mixed conifer forest so prevalent in the Sierra is precluded here, probably because local elevations are not high enough to attain the climatic conditions necessary for extensive development of these elements into a mixed forest. In addition, the Santa Lucian P. ponderosa appears to be a low elevation tree not even reaching the upper slopes of the highest mountains in the area. Thus, perhaps a genetic basis or strong competition precludes the local P. ponderosa populations from mixing with the relict stands of Sierran conifers.

BOUNDARIES

The boundaries for the Limekiln Creek R.N.A. as proposed by the Forest Supervisor in 1975 are almost entirely political and include all of Sections 3, 11, and 14, plus all of Section 2 south of the Twin - Cone Peak divide, the E 3/4 of Section 16, a 200 acre L - shaped portion on the north and east sides of Section 15 and a small ca. 40 acre portion of Section 22, T. 22 S. - R 4 E. House of Representatives bill 4459 in March 1975 proposed an extension of the boundaries of the Los Padres National Forest to include the following sections: 4, 5, 6, 7, 8, 9, 16, 17, 18, and 25 in T 22 S - R 4 E Mt. Diablo Meridian. This means that all of the drainage, except for the Cowell Foundation holdings which amount to 160 acres in the west portion of Section 10, 120 acres in the north-east portion of Section 16 and 360 acres in the southwest portion of Section 15, (and some other small private holdings) would be under the jurisdiction of the Forest Service. However, according to Monterey District Resources Officer, Bob Addison (pers. comm. 1976) the passage of this bill is not immediately forseeable. We have therefore kept to the original boundaries of U. S. Forest Service land when considering the extent of this proposed R.N.A. In this proposal the western boundary will remain the same as in the original proposal, but the northern boundary will follow the drainage divide southeast over the summits of Twin and Cone Peaks to its intersection with the eastern border of Section 12. A 195 acre portion of Section 12 (see Map Appendix I) will be excluded. This portion forms a corridor from the trailhead on the Cone Peak Road to Vicente Camp along Hare Canyon. This is the only major Forest Service campsite within the drainage. The

addition of the portion of Sections 12 and 13 within the drainage is justified we feel,because of the fine representation of mixed evergreen forest with a rich understory of grasses and herbs. The southern portion of the area remains the same as it was in the original proposal. The northern ½ of Section 12 and the portion of Section 1 within the drainage are included because of the interesting juxtaposition of redwood forest, mixed evergreen, chaparral, and canyon live oak woodland. The total acreage of the proposed R.N.A. is ca. 4264 acres.

IMPACTS AND RECOMMENDATIONS

Grazing:

From February 1 to July 1 the Monterey District allows 20 head of cattle to graze on the Twitchel Allotment covering the grassy portions of the two central ridges. However, we have seen cattle in the area in late July, mid-August and in early January. The impact of grazing on the grassland and adjacent coast live oak woodland on Twitchel Ridge is pronounced. The understory of the oak woods shows substantial damage, with marked trampling and overgrazing obvious on many of the herbs shrubs and grasses. The lower grassy slopes generally show more damage in the form of high weed density and bare areas than do the upper slopes. The effect of grazing upon the stability of the grasslands and adjacent vegetation types was discussed earlier. Although cattle grazing may aid in maintaining grassland its effect certainly isn't natural. Therefore, we recommend that grazing be totally eliminated from the proposed R.N.A.

Recreation:

The major forms of recreation in the drainage are hiking and camping, the most heavily used areas being the Cowell Camping

concession at the mouth of the creek, Vicente Camp and the trail leading to it from Cone Peak Road, and the trail to the summit of Cone Peak. The camping concession has trails leading to the lime-kilns, the waterfall on the Main Fork and up into Hare Canyon, but these do not affect the surrounding Forest Service land. Vicente Camp is a small, well-used forest service campground. It seems reasonable to exclude this camp and most of its access trail from the proposed R.N.A. so that its use would not impinge upon the integrity of the area. The trail to Cone Peak traverses steep rocky terrain and yet is fairly heavily used. The major impact on the vegetation is the short-cutting of switch-backs on the steeper sections, but this has not become extremely serious yet. The vegetation in this steep area is dominated by shrubby Quercus chrysolepis and doesn't appear to have much herbaceous cover which could be adversely affected. The trails crossing the central ridges and ascending the West Fork Canyon are lightly traveled (except by cattle) and at the present level of use will not have a significant impact. The impact of hunting on the area is not clear. Black bear seem to have been recently eliminated from the drainage (Ray Collett pers. comm.) but no other noticable effects are obvious. Whether the present level of hunting will detract from the integrity of the area is not known. It seems likely that the hunting pressures in the main portion of the R.N.A. would be minimal, because of light use, hence hunting could be allowed to continue unless adverse effects are demonstrated.

Mining and Logging:

The four Limekilns, for which the creek was named, were closed down in 1890 and have remained inactive ever since. Hart (1966) states that because the quantity of good quality limestone available

at the landslide area where the kilns are located is small, it is unlikely that further commercial development will take place there. He also states that a number of the limestone outcrops farther up on the ridge are dolomitic and laced with granitic dikes and metamorphics and are thus not of good enough quality for the production of lime.

The only obvious logging done in the drainage occurred on Cowell land on redwoods along the lower West Fork, Main Fork and Hare Canyon. The wood was probably used, at least partially, to supply the limekilns. No recent logging has been done within the proposed R.N.A. and none seems to have occurred in the upper reaches of any of the canyons. Some logging of Ponderosa pine may have been done on the ridge west of the West Fork outside of the proposed boundary.

Roads:

The only inland road which could have direct impact on the R.N.A. would be the Cone Peak Road where it contacts the proposed boundary at the head of Hare Canyon. If impact on this grassy area from the adjacent small parking strip seems likely to be too heavy, the boundary could be moved away from the road several yards at this location. Along the coast, Highway 1 crosses a narrow segment of the proposed R.N.A. Whether or not the effects of road maintenance on the adjacent steep slopes would have a severe impact on the vegetation there requires further study. The transect of coastal scrub in that area is important to the overall ecological values of the R.N.A. Perhaps a corridor extending several yards to each side of the highway would avoid major damage to the vegetation within the reserve.

Overall Recommendations:

In our opinion the proposed Limekiln Creek R. N. A. could be easily managed. It is a well-defined geographical area with little conflicting public interest in it at the present time. If the additional land proposed by House Bill 4459 is acquired, we would recommend that as much of the West Fork watershed as possible be included within the R.N.A. to insure its integrity and to include the Ponderosa pine groves on the west ridge. In this report we did not emphasize the importance of the immediate coast. The extension of the coastal boundaries of the R.N.A. to include a greater diversity of coastal bluff and scrub vegetation as well as the intertidal habitat could be accomplished by extending the boundary along the coast some distance east of the eastern edge of Section 22, T 22 S - R 4 E. The area's biological values are well recognized by the Forest. All five alternate plans in the latest "Big Sur Coastal Planning Unit (1976) call for maintaining the largest portion of the drainage in a roadless condition and three plans suggest botanical area protection. Wilderness designation is undesirable for the drainage for reasons of fire safety given in Appendix II of the Planning Unit Report.

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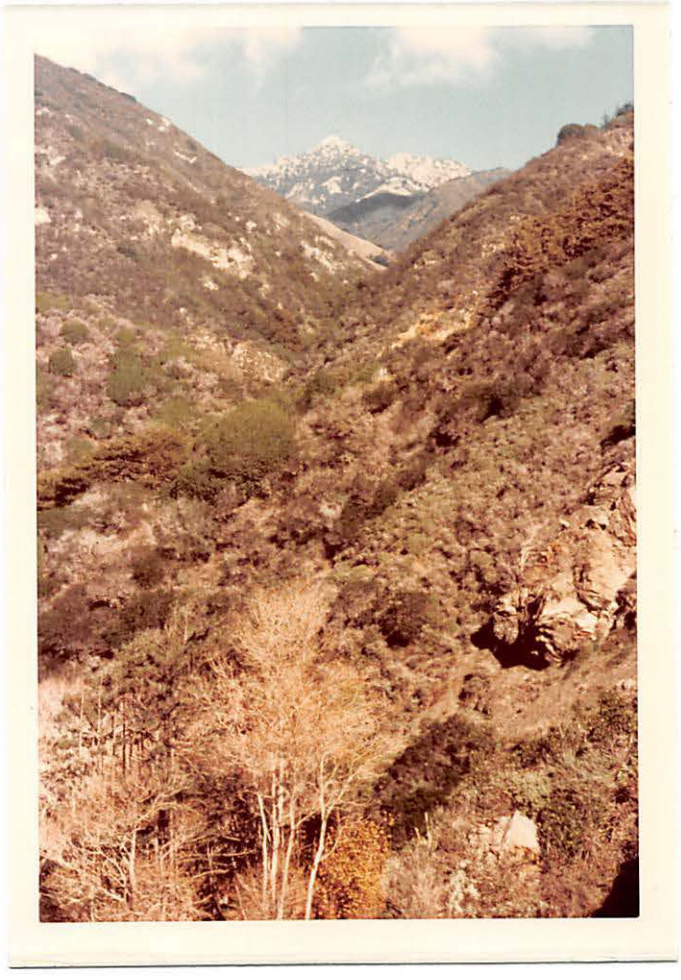

From Highway 1 to Cone Peak (snow on summit). January 1977.

From the Santa Lucia mixed conifer forest on Cone Peak to the mouth of Limekiln Creek. Pinus lambertiana in foreground. July 1976.

APPENDIX II

TERRESTRIAL VERTEBRATES OF THE LIMEKILN CREEK DRAINAGE

Reptiles and Amphibians
Known From or Suspected in Drainage

California newt Taricha torosa - West Fork redwoods

Yellow-eyed salamander Ensatina eschscholtzi - West Fork, common

Slender salamander Batrachoseps relictus - West Fork, common

Arboreal salamander Aneides lugubris - suspected in mixed evergreen, oak woodland

Western toad Bufo boreas - suspected

Pacific treefrog Hyla regilla - Twitchel site

Western fence lizard Sceloporus occidentalis - common throughout

Western skink Eumeces skiltonianus - Vicente Camp, upper Hare Canyon

California whiptail Cnemidophorus tigris - chaparral east of Cone Peak

Southern alligator lizard Gerrhonotus multicarinatus - oak woodland, Twitchel Ridge

Northern alligator lizard Gerrhonotus coeruleus - upper Hare Canyon

Rubber boa Charina bottae - suspected

Ringneck snake Diadolphis punctatus - suspected

Western racer Coluber constrictor - grassland, west slope of Hare Canyon

Striped racer Masticophis lateralis - chaparral, Twin Peak

Gopher snake Pituophis melanoleucus - chaparral, mixed evergreen, Hare Canyon

Mountain kingsnake Lampropeltis zonata - Griffin (1976) noted one on Cone Peak

Aquatic garter snake Thamnophis couchi - suspected

Terrestrial garter snake Thamnophis elegans - suspected

Pacific rattlesnake Crotalus viridis - chaparral, Cone Peak

Birds Seen in the Limekiln Drainage

This list includes only land bird species seen in late July mid-August and early January, 1976-77. A number of coastal shore birds and sea birds could be added to the list as well as some spring breeders and regular fall and spring migrants.

California condor - an immature seen on July 29 over east flank of Cone Peak

Turkey vulture - resident

Sharp-shinned hawk - seen in winter Twitchel Ridge

Cooper's hawk - Hare Canyon, July and August

Red-tailed hawk - resident

American kestrel - resident

California quail - resident, lower elevations

Mountain quail - resident, mid and upper elevations

Band-tailed pigeon - resident

Great horned owl - resident, Hare Canyon

Screech owl - July and August, Hare Canyon

Spotted owl - resident

Pygmy owl - July and August, Hare Canyon

White-throated swift - resident

Vaux swift - migrant, August

Allen's hummingbird - July and August

Anna's hummingbird - resident

(Red shafted) Flicker - resident

Acorn woodpecker - resident

Hairy woodpecker - resident

Nuttalls woodpecker - resident

Ash-throated flycatcher - July and August

Black phoebe - August, January

Says phoebe - January, Twitchel ridge

Western flycatcher - July, August

Western pewee - July, Cone Peak

Olive-sided flycatcher - July

Stellar's jay - resident

Scrub jay - resident

Raven - resident

Crow - resident

Mountain chickadee - resident, Twin Peak-Cone Peak sugar pines

Chestnut-backed chickadee - resident

Plain titmouse - resident

Common bushtit - resident

Red-breasted nuthatch - resident, Twin Peak-Cone Peak sugar pines

Brown creeper - resident

Wrentit - resident

Dipper - resident, Hare Canyon

House wren - July

Winter wren - August, Hare Canyon

Bewicks wren - resident

Canyon wren - resident, Hare Canyon, Middle Fork Canyon

Rock wren - August, Twitchel Ridge

California thrasher - resident

Robin - January

Varied thrush - January

Hermit thrush - January

Western bluebird - July and August

Blue-gray gnatcatcher - July

Golden-crowned kinglet - January

Ruby-crowned kinglet - January

Huttons vireo - resident

Solitary vireo - July and August

Warbling vireo - July

Orange-corwned warbler - July

Yellow-rumped warbler - January

Black-throated gray warbler - July and August

Townsends warbler - January

Wilson's warbler - July

Western meadowlark - resident

Western tanager - July

Black-headed grosbeak - July

Purple finch - January

House finch - resident

Pine siskin - January

Lesser goldfinch - resident

Rufous-sided towhee - resident

Brown towhee - resident

Rufous-crowned sparrow - resident

Dark-eyed junco - resident

Chipping sparrow - July and August

White-crowned sparrow - winter and resident

Golden-crowned sparrow - winter

Song sparrow - resident

Mammals Seen or of Probable Occurrence

in the Drainage

Trowbridge shrew Sorex trowbridgei - suspected

Ornate shrew Sorex ornatus - suspected

Broad-handed mole Scapanus latimanus - redwood, mixed evergreen

Little brown bat Myotis lucifugus - suspected

Long-eared bat Myotis evotis - suspected

Long-legged bat Myotis volans - suspected

California bat Myotis californicus - head of Hare Canyon

Yuma bat Myotis yumanensis - suspected

Fringed bat Myotis thysanodes - suspected

Small-footed bat Myotis subulatus - suspected

Silvery haired bat Lasionycteris noctivagens - suspected

Western pipistrel Pipistrellus hesperius - head of Hare Canyon

Big brown bat Eptisicus fuscus - suspected

Red bat Lasiurus borealis - suspected

Hoary bat Lasiurus cinereus - head of Hare Canyon

Pallid bat Antrozous pallidus - suspected

Free-tailed bat Tadarida brasiliensis - suspected

Lump-nosed bat Plecotus townsendii - suspected

Brush rabbit Sylvalagus bachmani - coastal scrub

Audubon cottontail Sylvalagus auduboni - suspected in chaparral

Blacktailed hare Lepus californicus - Cone Peak Road

Merriam chipmunk Eutamias merriami - common in forest and scrub

Beechey ground squirrel Citellus beecheyi - grassland, Twitchel Ridge

Western gray squirrel Sciurus griseus - common in forests

Valley pocket gopher Thomomys bottae - forest and grassland

Santa Cruz kangaroo rat Dipodomys venustus - suspected

Deer mouse Peromyscus maniculatus - suspected

Brush mouse Peromyscus boylei - suspected

Pinyon mouse Peroyscus truei - suspected

California mouse Peroyscus californicus - suspected

Dusky-footed woodrat Neotoma fuscipes - redwood, mixed evergreen

California meadow mouse Microtus californicus - grassland, western Hare Canyon

Coyote Canis latrans - scats seen in chaparral, mixed evergreen

Grey fox Uriocyon cinercoargenteus - scats chaparral

California ringtail Bassariscus astutus - suspected

Raccoon Procyon lotor - suspected

Long-tailed weasel Mustella frenata - suspected

Badger Taxidea taxus - suspected, grassland

Spotted skunk Spilogale putorius - suspected

Striped skunk Mephitis mephitis - suspected

Mountain lion Felis concolor - tracks seen in upper Hare Canyon

Bobcat Lynx rufus - suspected

Black-tailed deer Odocoileus hemonus - common throughout

APPENDIX III

List of Vascular Plants

of the Limekiln Creek Drainage

This list includes all species we identified within the drainage plus some taxa listed for the Cone Peak Trail or other parts of the drainage by Howitt and Howell (1964 and 1973). The abbreviations along side of the names indicate the community types in which they have been found.

cs = coastal scrub
ss = sage scrub
Ct = Ceanothus thyrsiflorus scrub
c = chaparral
g = grassland
ts = transitional scrub
r = redwood forest
me = mixed evergreen
Qa = coast live oak woodland
co = canyon oak woodland
Slc = Santa Lucia mixed conifer

SELAGINELLACEAE

Selaginella bigelovii - ss, ts, c

PTERIDACEAE

Adiantum capillus-veneris - me, r
Adiantum jordani - me, r
Adiantum pedatum var. aleuticum - r
Aspidotis californica - me, r
Cheilanthes intertexta - co, Slc
Cheilanthes gracillima - co, Slc
Cheilanthes cooperae - Qa
Cheilanthes covillei - me
Pellaea andromedaefolia - me, Qa, ss, c
Pellaea mucronata - ss, c
Piryrogramma triangularis - me
Pteridium aquilinum - g, me, Qa

ASPIDIACEAE

Cystopteris fragilis - r
Dryopteris arguta - me, cs
Polystichum curtum - c, co

Polystichum dudleyi - r
Polystichum munitum - r, me

BLECHNACEAE

Woodwardia fimbriata - r, me

POLYPODIACEAE

Polypodium californicum - r, me

PINACEAE

Abies bracteata - Slc, co, me, r
Pinus coulteri - Slc, co, me
Pinus lambertiana - Slc, co
Pinus ponderosa - Slc, Qa, co
Pseudotsuga menziesii - r, me

TAXODIACEAE

Sequoia sempervirens - r

CUPRESSACEAE

Calocedrus decurrens - out of drainage on E slope Cone Peak

LAURACEAE

Umbellularia californica - me, Qa, co, r

PAEONIACEAE

Paeonia californica - a, g

RANUNCULACEAE

Aquilegia formosa var. truncata - me
Clematis lasiantha - c, ss
Delphinium nudicaule - me
Ranunculus californicus - g
Thalictrum polycarpon - cs

GERANIACEAE

Erodium botrys - g
Erodium cicutarium - g, ss
Geranium dissectum - g
Geranium molle - g, Qa

OXALIDACEAE

Oxalis oregana - r

POLYGALACEAE

Polygala californica - g, me Qa

EUPHORBIACEAE

Eremocarpus setigerus - g
Euphorbia lathyris - Qa

VIOLACEAE

Viola sempervirens - r

PAPAVERACEAE

Dendromecon rigida - c
Eschscholzia californica - g, cs

FUMARIACEAE

Dicentra chrysantha - c (along Cone Peak Road)

CRUCIFERAE

Arabis breweri - co, me, Slc
Brassica nigra - g
Capsella bursa-pastoris - g
Cardamine oligosperma - g
Dentaria californica - r
Erysimum capitatum - me, Slc
Streptanthus glandulosus - c
Streptanthus tortuosus - co

CARYOPYLLACEAE

Arenaria douglasii - co, me
Cerastium viscosum - g
Polycarpon tetraphyllum - Qa
Silene gallica - g
Stellaria media - g, Qa

PORTULACACEAE

Calandrinia breweri - g
Montia perfoliata - Qa, me

POLYGONACEAE

Chorizanthe californica - g
Chorizanthe douglasii - g, ss, c, co
Chorizanthe membranacea - g, ss, c
Chorizanthe staticoides - c
Chorizanthe vortriedei - g, c
Eriogonum elongatum - ts, ss, c

Phacelia egena - co
Phacelia imbricata - g, me, c, ss
Phacelia malvaefolia var. loasaefolia - cs, ss

BORAGINACEAE

Cryptantha muricata var. jonesii - c, co
Plagiobothrys nothofulvus - g

SOLANACEAE

Solanum douglasii - cs, me
Solanum marginatum - me

SCROPHULARIACEAE

Castilleja affinis - cs, ss, c, me
Castilleja foliolosa - cs, ss
Castilleja latifolia - cs
Castilleja martinii - co, Slc
Collinsia childii - co
Collinsia heterophylla - Qa
Cordylanthus rigidus - g, co, c, ts
Mimulus aurantiacus - cs, ss, c, me
Mimulus bifidus ssp. fasciculatus - ss, c
Mimulus guttatus - cs
Mimulus subsecundus - me
Pedicularis densiflora - me
Penstemon breviflorus - ts, me, co
Penstemon centranthifolius - co, g
Penstemon corymbosus - co, me
Penstemon heterophyllus ssp. australis - co, g
Scrophularia californica - me, cs

VERBENACEAE

Verbena lasiostachys - g

LABIATAE

Marrubium vulgare - g
Monardella villosa ssp. subglabra - c, ss
Salvia columbariae - g, me, ss
Salvia leucophylla - ss
Salvia mellifera - ss, cs, c
Satureja douglasii - Qa, me
Stachys bullata - me, r
Stachys pycnantha - r
Trichostema lanatum - c
Trichostema lanceolatum - g

CRASSULACEAE

Dudleya caespitosa - cs

Eriogonum fasciculatum var. foliolosum - ss, c, ts
Eriogonum latifolium - cs
Eriogonum parvifolium - cs
Eriogonum saxatile - co
Eriogonum virgatum - co
Rumex acetosella - g

PRIMULACEAE

Anagallis arvensis - g, Qa
Trientalis latifolia - me, r

PLANTAGINACEAE

Plantago lanceolata - g

ERICACEAE

Arbutus menziesii - me, Slc, Qa, co
Arctostaphylos crustacea - c
Arctostaphylos glandulosa - c
Arctostaphylos hooveri - c (high on Cone Peak)
Vaccinium ovatum - r

APOCYNACEAE

Cycladenia humilis var. venusta - may occur on Cone Peak Ridge

ASCLEPIADACEAE

Asclepias californica var. greenei - co, Slc

CONVOLVULACEAE

Convolvulus cyclosteguis - cs
Convolvulus occidentalis - ss, c

CUSCUTACEAE

Cuscuta californica - ss

POLEMONIACEAE

Collomia heterophylla - me, co
Linanthus androsaceus - g, me
Linanthus ciliatus - g
Linanthus liniflorus - g

HYDROPHYLLACEAE

Eriodictyon californicum - c, ss
Eucrypta chrysanthemifolia - cs
Nemophila parviflora - me
Phacelia cicutaria var. hispida - me
Phacelia douglasii - me, co

SAXIFRAGACEAE

Boykinia elata - r
Heuchera micrantha var. pacifica - r
Lithophragma heterophyllum - me, Qa
Ribes malvaceum - me
Ribes menziesii var. hystrix - r, me
Ribes sanguineum var. glutinosum - r
Saxifraga californica - me
Whipplea modesta - me, r

ROSACEAE

Adenostoma fasciculatum - c, ss
Fragaria californica - me, Qa
Heteromeles arbutifolia - cs, ss, c, me
Holodiscus discolor - cs, me
Rosa gymnocarpa - me, Qa
Rubus parviflorus var. velutinus - r
Rubus vitfolius - me, Qa

LEGUMINOSAE

Astragalus nuttallii - cs
Lathyrus vestitus ssp. puberulus - me, ss, c
Lotus argophyllus var. fremontii - c, co
Lotus benthamii - cs, ss
Lotus crassifolius - c
Lotus grandiflorus var. mutabilis - co
Lotus humistratus - g
Lotus micranthus - g
Lotus salsuginosus - g
Lotus scoparius - cs, ss, c, ts
Lotus strigosus - g, co
Lupinus albifrons - ts, ss, Slc, co
Lupinus arboreus - cs
Lupinus concinnus - c
Lupinus hirsutissimus - ss, c
Lupinus latifolius - g, me
Lupinus variicolor - cs
Medicago hispida - g
Trifolium bifidum - g
Trifolium microcephalum - g
Trifolium tridentatum - g, me

PLATANACEAE

Platanus racemosa - r

BETULACEAE

Alnus rhombifolia - r

FAGACEAE

Lithocarpus densiflorus - me, r, Slc

Quercus agrifolia - Qa, me
Quercus chrysolepis - co, me, Slc
Quercus wislizeni - me, Qa, co
Quercus wislizeni var. fructescens - c

MYRICACEAE

Myrica californica - r

SALICACEAE

Salix coulteri - r
Salix lasiolepis - cs

ONAGRACEAE

Clarkia rhomboidea - g, co, ts, ss
Clarkia speciosa - g, ss
Epilobium paniculatum - g, ss
Zauschneria californica - ss, c, cs
Zauschneria californica ssp. mexicana - c, ss, co
Zauschneria cana - cs

RHAMNACEAE

Ceanothus dentatus - co, c
Ceanothus griseus - Ct, cs
Ceanothus integerrimus - c
Ceanothus oliganthus - c
Ceanothus papillosus var. roweanus - c
Ceanothus sorediatus - Ct, ss, c
Ceanothus thyrsiflorus - Ct, cs, ss
Rhamnus californica - cs, ss, me, c, Qa
Rhamnus crocea - cs
Rhamnus crocea ssp. ilicifolia - ss, c

LORANTHACEAE

Arceuthobium campylopodum - me, Slc
Phoradendron villosum - me, co

ACERACEAE

Acer macrophyllum - me, r

ANACARDIACEAE

Rhus diversiloba - cs, ss, c, me, Qa, co, r

ARALIACEAE

Aralia californica - r

UMBELLIFERAE

Foeniculum vulgare - cs

Heracleum lanatum - cs
Osmorhiza chilensis - me, r
Sanicula crassicaulis - Qa, me

CORNACEAE

Cornus occidentalis - r

GARRYACEAE

Garrya flavescens var. pallida - c

RUBIACEAE

Galium angustifolium - ss, ts, c
Galium californicum - me
Galium californicum ssp. flaccidum - me, co, Slc
Galium californicum ssp. luciense - co, Slc
Galium clementis - co, Slc
Galium nuttallii - cs, ss, c
Galium triflorum - me

CAPRIFOLIACEAE

Lonicera hispidula var. vacillans - me, Qa
Lonicera interrupta - c, me
Sambucus mexicana - me, r
Symphoricarpos mollis - me, r

CUCURBITACEAE

Marah fabaceus - ss, g, Qa, ss

COMPOSITAE

Achillea millefolium - cs, g, me
Artemisia californica - cs, ss, ts
Artemesia douglasiana - ss, me, Qa
Aster chilensis - cs
Baccharis pilularis var. consanguinea - cs, ss (lower levels)
Brickellia californica - ss, ts, c, co
Calycadenia truncata - g
Centaurea melitensis - g, ss
Chrysopsis villosa var. sessiliflora - ts, g, c, co
Cirsium californicum - g, ss, c
Conyza canadensis - cs
Erigeron petrophilus - co
Eriophyllum confertiflorum - cs, ss, ts, c, co
Eriophyllum staechadifolium - cs
Gnaphalium beneolens - ss, c
Gnaphalium bicolor - cs
Gnaphalium californicum - cs, ss, Qa
Gnaphalium microcephalum - cs, ss
Gnaphalium palustre - cs
Gnaphalium ramosissimum - cs, ss
Haplopappus squarrosus - cs, ss, ts, c

Hieracium albiflorum - r, me
Hieracium argutum var. parishii - me
Lagophylla ramosissima - g
Madia elegans - Qa
Madia gracilis - g, me
Madia madioides - g, me
Microseris heterocarpa - g
Petasites palmatus - r
Silybum marianum - g
Solidago californica - me, co
Solvia sessilis - g
Stephanomeria cichoriacea - cs, ss, c
Stephanomeria virgata - cs, ss, c, g, ts

LILIACEAE

Calochortus albus - me
Calochortus albus var. rubellus - me
Chlorogalum pomeridianum var. divaricatum - g, ss
Disporum hookeri - me, r
Smilacina racemosa var. amplexicaulis - r
Trillium chloropetalum var. giganteum - r
Trillium ovatum - r
Zigadenus fremontii - g, ts

AGAVACEAE

Yucca whipplei ssp. percursa - cs, ss, ts, co, c

AMARYLLIDACEAE

Brodiaea pulchella - g, ts

IRIDACEAE

Iris douglasiana - me, Qa
Sisyrinchium bellum - g

ORCHIDACEAE

Epipactis gigantea - r
Habenaria elegans - me

CYPERACEAE

Carex globosa - me
Carex multicaulis - Slc
Carex sp. - me

GRAMINEAE

Aira caryophyllea - g
Avena barbata - g, ts
Avena fatua - g, ts
Bromus diandrus - g

Bromus grandis - me
Bromus rubens - g, ts
Calamagrostis rubescens - me
Cortaderia selloana - cs
Distichlis spicata var. stolonifera - cs
Elymus glaucus - me, co
Elymus triticoides - me, Qa
Festuca californica - me
Festuca megalura - g, ts
Festuca myuros - g, c
Melica hartfordii - me
Melica imperfecta - me
Poa howellii - g, ts
Poa scabrella - ts, c, g
Poa sp. - me
Sitanion jubatum - c, ss, ts, g
Stipa coronata - c, co, ss
Stipa pulchra - g, ts, ss

From Twitchel Ridge. Salvia leucophylla in foreground, Ceanothus thyrsiflorus scrub in mid-background (August 1976).

Mixed chaparral, Arcostaphylos glandulosa dominant on Twin Peak, looking to canyon live oak woodland and Santa Lucia mixed conifer forest on Cone Peak (July 1976).

Sage scrub of Artemisia californica, Eriogonum fasciculatum, and Mimulus bifidus ssp. fasciculatus, west slope of Hare Canyon (August 1976).

From mixed evergreen forest of upper Hare Canyon, looking to grassland, transitional scrub, chaparral, and coast live oak woodland (August 1976).

Coast live oak woodland, transitional scrub, and chamise chaparral bordering on interior grassland. Ridge between Main Fork and Hare Canyon (August 1976).

From the mixed evergreen forest of Hare Canyon to Cone Peak; chamise chaparral, mixed evergreen forest, and canyon live oak woodland on slopes (July 1976).

Adiantum pedatum, Oxalis oregana, Vaccinium ovatum, etc., of the redwood-riparian forest, West Fork (August 1976).